Pineal Region Tumors: Computed Tomographic-Pathologic Spectrum

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Pineal Region Tumors: Computed Tomographic-Pathologic Spectrum

While several computed tomographic (CT) studies of posterior third ventricular neoplasms have included descriptions of pineal tumors, few reports have concentrated on these uncommon lesions. Some authors have asserted that the CT appearance of many pineal tumors is virtually pathognomonic. A series of nine biopsy-proved pineal gland and eight other presumed tumors is presented that illustrates their remarkable heterogeneity in both histopathologic and CT appearance. These tumors included germinomas, teratocarcinomas, hamartomas, and other varieties. They had variable margination, attenuation, calcification, and suprasellar extension. Germinomas have the best response to radiation therapy. Biopsy of pineal region tumors is now feasible and is recommended for treatment planning.

Tumors of the pineal region account for less than 2% of all intracranial neoplasms [1]. While several reports of computed tomography (CT) of third ventricular neoplasms have included an occasional pineal tumor [2, 3], few have focused on the radiographic spectrum of these uncommon lesions [4]. Some authors have asserted that the CT appearance of many pineal tumors is virtually pathognomonic [5]. We studied a series of nine biopsy-proven pineal gland tumors that demonstrated remarkable heterogeneity in both histopathologic and CT appearance.

Materials and Methods

A total of 17 pineal gland tumors were detected in 15,000 consecutive CT scans. Four patients were female and 13 were male. Mean age for the females was 27 years; for the males, 15 years. Initial symptoms ranged from headache, nausea, and vomiting, to Parinaud syndrome, visual field defects, diabetes insipidus, and hypopituitarism (table 1). Plain and contrast-enhanced CT scans were obtained in all cases.

Nine of the 17 cases were proven by biopsy or autopsy. Two were germinomas (atypical teratomas), two were teratocarcinomas, and one each was pineal hamartoma, benign teratoma, astrocytoma, and neurilemmoma. One other case was designated as a "malignant pineal tumor" by cerebrospinal fluid cytology. One case had insufficient tissue for pathologic diagnosis. One case was diagnosed as a pineal lipoma from characteristic CT findings. The dramatic response of five other cases to radiation therapy led to the presumptive clinical diagnosis of germinoma (table 1); these had no evidence of residual or recurrent disease for a minimum of 3 years. One patient was lost to follow-up.

Results

Germinoma (Atypical Teratoma)

The two documented and five presumed germinomas were either isodense or slightly hyperdense on plain CT scan (fig. 1A) and showed marked, uniform increase in attenuation after contrast enhancement (fig. 1B). Several were well
<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age, Gender</th>
<th>Presenting Symptoms</th>
<th>CT Appearance</th>
<th>Biopsy</th>
<th>Treatment/Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6, M</td>
<td>Diplopia, headache, nausea, vomiting, CN III, IV palsy</td>
<td>Isodense noncalcified posterior third ventricular mass, irregular margins, inhomogeneous contrast enhancement</td>
<td>Germinoma</td>
<td>Complete resolution following ventricular shunting, surgery, and radiation therapy</td>
</tr>
<tr>
<td>2</td>
<td>17, M</td>
<td>Anorexia, diabetes insipidus, panhypopituitarism</td>
<td>Well marginated, hyperdense mass left basal ganglia with strong contrast enhancement, edema, obstructive hydrocephalus secondary to aqueduct stenosis; subtle ependymal enhancement, third ventricle</td>
<td>Atypical teratoma with prominent germinomatous elements (autopsy)</td>
<td>Died 2 years after initial presentation; atypical teratoma with suprasellar, pineal, basal ganglia, ependymal involvement diagnosed at postmortem</td>
</tr>
<tr>
<td>3</td>
<td>18, M</td>
<td>Vomiting, diabetes insipidus, Parinaud syndrome, panhypopituitarism</td>
<td>Well delineated hyperdense suprasellar, posterior third ventricular masses; Ca++ in pineal region. Strong contrast enhancement of masses and ventricular ependyma; obstructive hydrocephalus</td>
<td>...</td>
<td>Complete resolution after ventricular shunt and radiation therapy; no recurrence after 4 years; presumptive diagnosis: germinoma</td>
</tr>
<tr>
<td>4</td>
<td>14, F</td>
<td>Headache, diplopia, papilledema, seizures</td>
<td>Well delineated slightly hyperdense posterior third ventricular mass without Ca++; strong, uniform contrast enhancement; moderate obstructive hydrocephalus</td>
<td>...</td>
<td>Ventricular shunt, radiation therapy with tumor reso- lution; 1 year follow-up; presumptive diagnosis: germinoma</td>
</tr>
<tr>
<td>5</td>
<td>26, M</td>
<td>Headache, vomiting, anorexia</td>
<td>Calcified isodense posterior third ventricular mass with moderate contrast enhancement, obstructive hydrocephalus</td>
<td>...</td>
<td>Complete resolution after ventricular shunting and radiation therapy; no recurrence after 5 years; presumptive diagnosis: germinoma</td>
</tr>
<tr>
<td>6</td>
<td>17, M</td>
<td>Headache, Parinaud syndrome, papilledema</td>
<td>Isodense third ventricular mass with strong contrast enhancement</td>
<td>...</td>
<td>Complete resolution after ventricular shunting and radiation therapy; 3 year follow-up without recurrence; presumptive diagnosis: germinoma</td>
</tr>
<tr>
<td>7</td>
<td>14, M</td>
<td>Headache, Parinaud syndrome</td>
<td>Well marginated hyperdense pineal region tumor with focal calcification, strong contrast enhancement, moderate obstructive hydrocephalus</td>
<td>...</td>
<td>Complete resolution after ventricular shunting and radiation therapy; no recurrence after 5 years; presumed germinoma</td>
</tr>
<tr>
<td>8</td>
<td>14, M</td>
<td>Headache, nausea, vomiting, diabetes insipidus, Parinaud syndrome</td>
<td>Well delineated isodense, calcified posterior third ventricular mass with strong contrast enhancement, moderate obstructive hydrocephalus</td>
<td>Teratocarcinoma</td>
<td>Died from widespread metastatic disease 1 year after diagnosis</td>
</tr>
<tr>
<td>9</td>
<td>18, M</td>
<td>Diabetes insipidus, panhypopituitarism</td>
<td>Lobulated, hyperdense suprasellar, posterior third ventricular masses with foci of calcification in the pineal tumor; strong but slightly inhomogeneous contrast enhancement</td>
<td>Teratocarcinoma</td>
<td>Apparent resolution of both masses following shunt and radiation therapy; recurrence of suprasellar component after 6 months; alpha-fetoprotein in CSF</td>
</tr>
<tr>
<td>Case No.</td>
<td>Age, Gender</td>
<td>Presenting Symptoms</td>
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<tr>
<td>10</td>
<td>6, M</td>
<td>Anisocoria, Parinaud syndrome discovered after head trauma</td>
<td>Well marginated posterior third ventricular mass with densely calcified rim, contrast-enhancing center; moderate hydrocephalus</td>
<td>Pineal hamatoma</td>
<td>Shunted with surgical removal; in coma 4 months postop with major residual neurologic deficits 2½ years later</td>
</tr>
<tr>
<td>11</td>
<td>8, M</td>
<td>Decreased coordination</td>
<td>Multicystic lobulated, irregular third ventricular tumor with foci of calcification, patchy peripheral contrast enhancement</td>
<td>Benign teratoma (with abundant neuroglial elements)</td>
<td>Residual mass and neurologic deficit following surgery (3 year follow-up)</td>
</tr>
<tr>
<td>12</td>
<td>63, M</td>
<td>Memory loss, imbalance</td>
<td>Well marginated isodense partially calcified posterior third ventricular mass with moderate obstructive hydrocephalus; uniform contrast enhancement</td>
<td>Neurilemmoma or pineocytoma with predominantly neural elements</td>
<td>Complete surgical removal</td>
</tr>
<tr>
<td>13</td>
<td>33, M</td>
<td>Dizziness, headache</td>
<td>Slight irregular hyperdense posterior third ventricular mass with focal calcification, patchy contrast enhancement</td>
<td>Midbrain astrocytoma</td>
<td>Unsuccessful radiation therapy; died 1 year following biopsy</td>
</tr>
<tr>
<td>14</td>
<td>42, F</td>
<td>Headache, vomiting</td>
<td>Well delineated low attenuation (~15 H) mass with peripheral calcification; no contrast enhancement; no hydrocephalus</td>
<td>...</td>
<td>Presumed lipoma because of CT characteristics</td>
</tr>
<tr>
<td>15</td>
<td>14, M</td>
<td>Anorexia, nausea, vomiting, diabetes insipidus</td>
<td>Slightly irregular enhancing, partially calcified posterior third ventricular mass; subtle suprasellar mass identified on multiple thin, overlapping axial scans; moderate obstructive hydrocephalus</td>
<td>&quot;Small malignant cells&quot; on CSF cytology</td>
<td>Complete resolution following ventricular shunting, radiation therapy (16 month follow-up)</td>
</tr>
<tr>
<td>16</td>
<td>20, M</td>
<td>Diplopia, Parinaud syndrome</td>
<td>Well demarcated hyperdense posterior third ventricular mass, small focus of Ca ++; strong contrast enhancement</td>
<td>Insufficient tissue</td>
<td>Resolving after radiation therapy (2 month follow-up only)</td>
</tr>
<tr>
<td>17</td>
<td>22, M</td>
<td>Diplopia, Parinaud syndrome</td>
<td>Irregular mixed density posterior third ventricular mass with foci of calcification, patchy contrast enhancement</td>
<td>...</td>
<td>Lost to follow-up</td>
</tr>
</tbody>
</table>

Note.—CN = cranial nerve, CSF = cerebrospinal fluid, postop = postoperative.

Marginated while others appeared less well circumscribed. Four cases had definite suprasellar involvement (fig. 2A). The suprasellar mass was quite subtle in two cases and required several overlapping thin sections for detection. One case demonstrated striking subependymal enhancement (fig. 2B). When present, calcification appeared limited to the pineal gland, which was itself engulfed by the tumor.

An atypical teratoma with prominent germinomatous elements was seen as a hyperdense mass in the basal ganglia with strong contrast enhancement and ependymal spread along the third ventricle (fig. 3). To our knowledge, only one similar case of documented "ectopic pinealoma" in the basal ganglia has been reported [6]. The present case was diagnosed at autopsy.

**Teratocarcinoma**

One case had a well demarcated, partly calcified, solitary posterior third ventricular mass that was slightly hyperdense on unenhanced CT scans. The lesion showed striking homogeneous increase in attenuation with contrast infusion (fig. 4). Although the CT appearance initially suggested
pineal germinoma, teratocarcinoma was found at surgery. A second case had lobulated hyperdense suprasellar and posterior third ventricular masses with scattered calcific foci. Strong but slightly inhomogeneous contrast enhancement was present (fig. 5). Complete resolution of these lesions after radiation therapy led to the presumptive diagnosis of germinoma. The suprasellar component recurred after 6 months. Biopsy disclosed a teratocarcinoma.

**Pineal Hamartoma**

The single pineal hamartoma had a striking peripheral calcified rim with a hyperdense center that enhanced after intravenous contrast administration (fig. 6).

**Benign Teratoma**

A large irregular, locally invasive lesion with mixed low and normal attenuation regions showed patchy contrast enhancement; one small focus of calcification was present (fig. 7).

**Pineal Parenchymal Neoplasms**

One hyperdense posterior third ventricular mass with strong contrast enhancement was either a neurilemmoma or pineocytoma with predominant neural elements (fig. 8).

**Astrocytoma**

One lobulated contrast-enhancing pineal region mass was found to be an astrocytoma at autopsy (fig. 9). It probably originated in the midbrain.

** Lipoma**

One homogeneous (~15 Hounsfield units [H]) noncontrast-enhancing lesion with a thin peripheral rim was identified in the pineal region. The CT characteristics were typical for lipoma.

**Discussion**

The term "pinealoma" has been loosely applied to all tumors arising from the pineal gland and posterior third ventricle. This practice has resulted in significant confusion in classifying the several varieties of tumors that arise from the pineal body.

Tumors arising from pineal parenchymal cells ("true pinealomas") are much less common than germ cell neoplasms (germinomas, teratomas, endodermal sinus tumors, or the rare primary intracranial choriocarcinoma) [7–9]. Parenchymal tumors have been subdivided into a more undifferentiated type composed primarily of immature cells (the so-called "pineoblastoma" is histologically similar to medulloblastoma) and pineocytoma with more mature com-
components. The latter can have either predominant astrocytic or neuroepithelial differentiation [10].

The remarkably divergent differentiating potential of pineal parenchymal tumors plus the considerable heterogeneity of germ cell neoplasms is reflected in their variable CT appearance. While calcification in pineal neoplasms suggests teratoma, it can also occasionally occur in pineal parenchymal tumors [4, 11]. Although ependymal or suprasellar involvement has been considered diagnostic of germinoma [5], teratocarcinoma can be radiographically indistinguishable (fig. 5). We found that a presumptive histologic diagnosis on the basis of CT alone was not possible. Uniformity or intensity of contrast enhancement, size, tumor margination, multiplicity, and location also were not helpful in distinguishing benign from malignant neoplasms. One well delineated, uniformly enhancing lesion was a teratocarcinoma (fig. 4), while a mixed density, locally invasive mass was histologically benign (fig. 7). Therefore, we found no definite correlation between CT appearance and tumor type.

While some authors have regarded periventricular contrast enhancement as virtually pathognomonic of germinoma [5], diffuse ventricular spread or invasion of the midbrain or basal ganglia can also occur with pineoblastoma or malignant teratoma [10]. One atypical teratoma with numerous germinomatous components was eccentrically located in the basal ganglia and at autopsy had marked ependymal and suprasellar involvement (fig. 3).

The term "ectopic pinealoma" has been used inaccurately to designate suprasellar germinoma [12]; embryonic nests of true pineal tissue have not been demonstrated in
that tissue diagnosis is now both taxic biopsy procedures for determining the most appropriate therapeutic regimen. Tumors are radiosensitive [16]. With more sophisticated techniques common since an estimated 70% for biopsy alone [15]. Ventricular shunting and radiation therapy without pathologic diagnosis were common since an estimated 70% of pineal region tumors are radiosensitive [16]. With more sophisticated microsurgical techniques [15], operative morbidity and mortality have declined [17, 18]. Accurate CT-guided stereotaxic biopsy procedures also may enhance treatment planning [19, 20]. An increasing number of investigators believe that tissue diagnosis is now both practical and necessary for determining the most appropriate therapeutic regimen.

**REFERENCES**